DOCUMENT RESUME

ED 408 293 SP 037 403

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TITLE Development of a Distance Learning Study Guide in Biomechanics.
PUB DATE Jun 97
NOTE 83p.
PUB TYPE Guides - Classroom - Learner (051)
EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Biomechanics; College Instruction; *Course Content; *Curriculum Development; *Distance Education; Higher Education; Instructional Materials; Literature Reviews; Nontraditional Education; Study Guides; Teaching Methods

ABSTRACT

The study guide presented here was created primarily from required course texts and recommended readings. A formative committee identified criteria for the content and format of the study guide, provided input on the philosophical and practical requirements, reviewed study guide questions, and provided feedback during the developmental stage. The summative committee validated the criteria identified by the formative committee and approved the draft of the study guide. The study guide consists of 200 multiple choice questions that allow the student to test his or her knowledge as it relates to the readings in the course. The results of this study indicated that the valid contents and appropriate format for a distance learning study guide in sports biomechanics can be determined. Three appendices, which comprise the bulk of the document, provide: (1) a list of required text books; (2) a list of recommended readings (general and sport specific); and (3) a copy of the study guide. (Contains 43 references.) (ND)

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ED 408 293

DEVELOPMENT OF A DISTANCE LEARNING STUDY GUIDE IN BIOMECHANICS

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June, 1997

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Abstract

The purpose of this study was to develop a distance learning study guide for Sports Biomechanics that is based on anatomical kinesiology and practical principles in the mechanics of human movement during physical activity. The distance learning study guide in biomechanics was created primarily from the required course texts and recommended readings. The study guide consists of 200 multiple choice questions that allow the student to test his or her knowledge as it relates to the readings in the course. It is clear from the results of this study that the valid content for a distance learning study guide in Sports Biomechanics can be determined. In addition, the appropriate format for a study guide can also be determined.

INTRODUCTION

Purpose of the Study

The purpose of this study was to develop a distance learning study guide for Sports Biomechanics that is based on anatomical kinesiology and practical principles in the mechanics of human movement during physical activity.

Research Questions

There were two research questions for this project. First, "What is the valid content for a distance learning study guide in Sports Biomechanics?" Second, "What is the appropriate format for the study guide?"

Definition of Terms

For the purposes of this study, the following terms need clarification.

Anatomical Kinesiology. Anatomical kinesiology is the study of movement, which includes the structural aspects of movement (Thompson & Floyd, 1994).

Biomechanics. Biomechanics is the application of mechanical principles to the study of living organisms (Hall, 1995).

Distance learning. Distance learning is the delivery of education or training through electronically mediated instruction and other forms of learning at a distance (United States Distance Learning Association, 1995).

Dynamics. Dynamics is the branch of mechanics dealing with systems subject to acceleration (Hall, 1995).

Kinematics. Kinematics is the study of the description of motion, including considerations of space and time (Hall, 1995).

Kinesiology. Kinesiology is the science of movement of the body (Rasch, 1989).

Kinetics. Kinetics is the study of the action of forces (Hall, 1995).

Mechanics. Mechanics is the branch of physics that analyzes the actions of forces on particles and mechanical systems (Hall, 1995).

Statics. Statics is the branch of mechanics that analyzes mechanical systems in a constant state of motion (Hall, 1995).

Study guide. A study guide is a collection of 200 multiple choice questions related to the topic of a particular course.

REVIEW OF RELATED LITERATURE

There is no totally new idea in learning, but as changes occur from generation to generation, effective teachers adjust their approaches to meet the needs of their learners (Baird & Monson, 1992). It is becoming increasingly important that faculty consider not only course content requirements, but also research in student development, learning theory, and ways to creatively utilize the tension between content and process. And so it is with distance learning (Garrison, 1989).

The roots of distance learning are traced to four primary media: print, voice, video, and computer (Leiner, Vinton, Clark, Kahn, Kleinrock, Lynch, Postel, Roberts, &

Wolff, 1997; Lewis, 1989, Saba, 1996; Steiner, 1996). In almost all cases, the student is placed in the driver's seat. Through distance learning we place confidence in our students by emphasizing construction of knowledge by learners themselves (Coombs, 1993). With distance learning, the student must assume more responsibility for his or her learning and may even have more than one alternative method of distance learning to choose from (Willis, 1992a, 1992b).

In discussing the development of courses for distance education it is first beneficial to define distance learning. The United States Distance Learning Association (1995) defines distance education as a method of electronic delivery for education or training purposes that does not exclude any form of delivery or educational programs (Willis, 1992a).

Too often today distance learning becomes the extensional operation that attempts to duplicate classrooms merely by dispersing lessons electronically throughout a geographic area. This approach takes the attention from the learner and focuses on the technology used for delivery. The outcome is educational programming driven by technology and not by learners' needs. Effective teaching at a distance is actually more the result of preparation than innovation, and the use of effective instructional techniques when there is a geographic separation of student and teacher (Parrott, 1995).

The use of innovation has fueled the business of education and created a subculture of the virtual university (Arvan, 1997; Schutte, 1997; Turoff, 1997). This new method of education has raised concerns over the issues of academic integrity. The

issue of academic integrity is crucial in developing a quality academic program whether it be virtual or traditional (Mayadas, 1997). Other concerns that begin to arise in the method of distance learning are factors such as students' perceptions, advising, psychological characteristics, and differences in students' performance in distance learning compared to traditional classroom instruction.

Students' Perceptions

Education requires continual feedback from students on their perceptions of the educational process and the delivery method being used. Students' perceptions allow administrators to evaluate the goals and objectives of the educational process and determine means by which to improve it (Applin, Mills, & Lyster, in press; Bothel & Applin, 1995).

With the advent of delivering education at a distance students' perceptions are more important now more than ever (Mills, Carney, Wallace, Williamson, & Walker, 1997). Distance learning is shaping how the American educational system is perceived by the consumer (i.e., the student) and is paramount to the success of any program (IBM, 1997; Western Governors Association, 1997; Wilson, 1997).

Research in Distance Learning Regarding the Learning Process

There has been some discussion of advising students from a distance in the research literature, but the discussion is normally a small part of a larger research effort and does not consider psychological characteristics (Jinkerson & Satterlund, 1996;

Bradley & Peacock, 1996; Stone, 1996; Moulds, 1996; Workman & Stenard, 1996; Wolcott, 1996). There has been research efforts concerning the factors that make distance learners successful. For instance, Charp (1994) found that active listening and the ability to work independently was crucial to the success of distance learning students. Schlosser and Anderson (1994) confirmed the findings of Charp (1994). Porter (1994) also found that teacher mediation increased the success rate of distance learning students. Further exploration into the specific psychological characteristics of distance learners and/or how this research can assist in the advising process seem warranted (Sherry, 1996).

There has also been considerable research regarding the performance of distance learning students compared to on-campus students. There have been 248 studies conducted between 1928 (Crump, 1928) and 1996 (Wilson, 1996) comparing the performance of distance learning and on-campus students (Russell, 1996a, 1996b, 1996c). All the studies have indicated no significant differences between distance learning and on-campus students.

Summary

The literature clearly indicates the need for the development of distance learning. There are even some individuals who postulate that what we know as distance learning today will be the traditional education of tomorrow. The need for developing specific instruments such as a study guide is but one small aspect of creating a quality distance learning option. Therefore, the purpose of this study was to develop a distance learning

study guide for Sports Biomechanics that is based on anatomical kinesiology and practical principles in the mechanics of human movement during physical activity.

METHODOLOGY AND PROCEDURES

The developmental methodology was used for this practicum. The first step was to read the required texts (see Appendix A), read the recommended readings for the course, review the literature in the area of biomechanics, and review the literature regarding the design and writing of multiple choice questions (Gronlund, 1982; Gronlund & Linn, 1990; McKeachie, 1994).

Second, a list of recommended readings necessary to fulfill the requirements of the study guide was constructed. A copy of the recommended readings has been included in Appendix B.

Third, the formative committee identified criteria for the content and format of the study guide, provided input on the philosophical and practical requirements, reviewed study guide questions, and provided feedback during the development stage. The summative committee validated the criteria identified by the formative committee.

Fourth, a draft of the study guide was developed. The draft was then submitted to the formative committee for the purpose of review before sending to the summative committee.

Fifth, the approved draft was reviewed by the summative committee for purposes of validating the content and format in accordance with the criteria. Revisions were

made as deemed necessary by the summative committee. A copy of the study guide is included in Appendix C.

Assumptions

For this practicum, it is assumed that members of the formative committee had adequate knowledge to guide the development of this project. It is also assumed that the summative committee's evaluation of the distance learning study guide was valid.

RESULTS

The distance learning study guide in biomechanics was created primarily from the required course texts (see Appendix A) and recommended readings (see Appendix B). Various books were referenced in regard to the development of multiple choice questions (Gronlund, 1982; Gronlund & Linn, 1990; McKeachie, 1994). The study guide consists of 200 multiple choice questions that allow the student to test his or her knowledge as it relates to the readings in the course.

The list of recommended readings necessary to fulfill the requirements of the study guide was constructed through the use of library research. A copy of the recommended readings has been included in Appendix B.

The formative committee identified criteria for the content and format of the study guide. The content was to be representative of the information contained in the required textbooks (80%) and recommended readings (20%). The formative committee provided input on the philosophical and practical requirements of the study guide which were

conducive with the nature of the problem, i.e., "The biomechanical curriculum should be based on the principles of anatomical kinesiology and the analysis of human movement in physical activity. The principles of kinetics and kinematics should not be theoretically based but studied through practical movement skills." Thus, the study guide reflected this philosophical and practical requirement. The formative reviewed study guide questions and provided feedback during the development stage. Most of the suggestions consisted of grammatical and logistical changes. The formative committee indicated that the content, format, philosophical, and practical recommendations had been met in the study guide draft.

The approved draft was reviewed by the summative committee for purposes of validating the content and format in accordance with the criteria. Minor revisions were made to some questions in regard to the difficulty of question as recommended by the summative committee. The questions that needed adjustment were the biomechanical computation questions. A copy of the study guide is included in Appendix C.

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Workman, J.J., & Stenard, R.A. (1996). Student support services for distance learners. Education at a Distance, 10(7), 18-22.

APPENDIXES

Appendix A

Required Textbooks

Hay, J.G. (1993). The biomechanics of sports techniques. Englewood Cliffs, NJ: Prentice-Hall.

Thompson, C.W., & Floyd, R.T. (1994). Manual of structural kinesiology. St. Louis, MO: Mosby-Year Book.

Appendix B

Recommended Readings

Abourezk, T., & Toole, T. (1995). Effect of task complexity on the relationship between physical fitness and reaction time in older women. Journal of Aging and Physical Activity, 3, 251-260.

Aitkens, S., Lord, J., Bernauer, E., Fowler, W. M., Lieberman, J. S., & Berck, P. (1989, March). Relationship of manual muscle testing to objective strength measurements. Muscle & Nerve, 12, 173-177.

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Sport Specific

Baseball

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Cycling

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Appendix C

Study Guide

1. Information derived from a combination of senses through muscle spindles, Golgi tendons, joint receptors, etc.

*a. kinestheses
b. kinematics
c. kinetics
d. kinesiology
e. none of the above

2. Concerned with position, velocity, and acceleration without reference to forces causing them.

a. kinestheses
*b. kinematics
c. kinetics
d. kinesiology
e. none of the above

3. Muscular contraction that occurs at a constant velocity over the full range of motion.

a. isometric
b. isotonic
*c. isokinetic
d. isoconcentric
e. none of the above

4. The constituents of bone tissue are:

a. calcium carbonate, water, and protein
b. calcium phosphate, water, and protein
c. calcium phosphate, and calcium carbonate
d. calcium phosphate and water
*e. none of the above

5. Interior bone is composed of what type of tissue?

*a. spongy
b. dense
c. spongy and dense
d. organic and spongy
e. none of the above

6. Exterior bone is composed of what type of tissue?

a. spongy
*b. dense
c. spongy and dense
d. organic and spongy
e. none of the above

7. All the following are bone types EXCEPT:

a. short
*b. intermediate
c. long
d. flat
e. irregular

8. Carpal, talus, and navicular bones are examples of what types of bones?

*a. short
b. intermediate
c. long
d. flat
e. irregular

9. The ischium, pubis, and vertebrae bones are examples of what types of bones?

a. short
b. intermediate
c. long
d. flat
*e. irregular

10. During ossification of long bones where does the distal and proximal growth of the bone begin?

a. diaphysis
b. triaphsis
*c. epiphysis
d. periosteum
e. none of the above

11. The femur and tibia are examples of what types of bones?

a. short
b. intermediate
*c. long
d. flat
e. irregular

12. The following are all types of joints EXCEPT:

*a. movable
b. immovable
c. slightly movable
d. freely movable
e. none of the above

13. The vascular synovial membrane provides _____ for a joint.

a. nourishment
b. lubrication
c. swelling
*d. secretion
e. none of the above

14. When the shoulder joint is abducting the shoulder girdle is

a. abducting
b. adducting
*c. upwardly rotating
d. downward rotating
e. none of the above

15. When the shoulder girdle is abducting the shoulder joint is

*a. internally rotating
b. externally rotating
c. flexing
d. extending
e. none of the above

16. The muscles of the shoulder girdle provide stability for the

a. clavicle
*b. scapula
c. humerus
d. rotator cuff
e. none of the above

17. Which is NOT a muscle of the shoulder girdle?

a. trapezius
*b. deltoid
c. levator scapulae
d. serratus anterior
e. none of the above

18. Where is the palpation of the levator scapulae?

a. under the trapezius
b. back of the neck
c. front and lateral side of the chest below the fifth and sixth ribs
d. under the pectoralis major muscle in the pit of the shoulder
*e. none of the above

19. Where is the origin of the rhomboid muscles?

a. transverse processes of the upper four cervical vertebrae
b. transverse processes of the lower four cervical vertebrae
*c. spinous processes of the last cervical and the first five thoracic vertebrae
d. spinous processes of the last cervical and the last five thoracic vertebrae
e. none of the above

20. Where is the insertion of the pectoralis minor muscle?

a. coronoid process of the scapula
*b. coracoid process of the scapula
c. spinous process of the clavicle
d. spinous process of the scapula
e. none of the above

21. Which of the following is NOT a muscle of the rotator cuff?

a. subscapularis
b. supraspinatus
c. infraspinatus
d. teres minor
*e. none of the above

22. Which of the following is NOT a movement of the shoulder joint?

a. abduction
b. adduction
c. flexion
*d. elevation
e. none of the above

23. Where is the insertion of the coracobrachialis muscle?

*a. middle of the medial border of the humeral shaft
b. tuberosity on the lateral humerus near the medial border
c. superiorly on the greater tubercle of the humerus
d. posteriorly on the greater tubercle of the humerus
e. none of the above

24. Where is the insertion of the infraspinatus muscle?

a. middle of the medial border of the humeral shaft
b. tuberosity on the lateral humerus near the medial border
c. superiorly on the greater tubercle of the humerus
*d. posteriorly on the greater tubercle of the humerus
e. none of the above

25. Where is the insertion of the teres minor muscle?

a. middle of the medial border of the humeral shaft
b. tuberosity on the lateral humerus near the medial border
c. superiorly on the greater tubercle of the humerus
*d. posteriorly on the greater tubercle of the humerus
e. none of the above

26. Where is the palpation of the subscapularis muscle?

*a. cannot be palpated
b. medial lateral border of the scapula
c. posterior aspect of the lateral scapula border
d. diagonally upward from the inferior angle of the scapula on the posterior surface
e. none of the above

27. Where is the palpation of the teres major muscle?

a. cannot be palpated
b. medial lateral border of the scapula
c. posterior aspect of the lateral scapula border
*d. diagonally upward from the inferior angle of the scapula on the posterior surface
e. none of the above

28. Where is the insertion of the biceps brachii muscle?

*a. tuberosity of the radius
b. olecranon process of the ulna
c. coronoid process and tuberosity of the ulna
d. middle third of the lateral surface of the radius
e. lateral surface of the distal end of the radius at the styloid process

29. Where is the insertion of the biceps brachioradialis muscle?

a. tuberosity of the radius
b. olecranon process of the ulna
c. coronoid process and tuberosity of the ulna
d. middle third of the lateral surface of the radius
*e. lateral surface of the distal end of the radius at the styloid process

30. Where is the insertion of the triceps brachii muscle?

a. tuberosity of the radius
*b. olecranon process of the ulna
c. coronoid process and tuberosity of the ulna
d. middle third of the lateral surface of the radius
e. lateral surface of the distal end of the radius at the styloid process

31. What is the action of the anconeus muscle?

a. extension of the wrist
*b. extension of the elbow
c. flexion of the wrist
d. flexion of the elbow
e. none of the above

32. What is the action of the supinator muscle?

a. supination of the hand
b. supination of the wrist
c. supination of the ulna
d. supination of the radius
*e. none of the above

33. What is the action of the pronator quadratus muscle?

a. pronation of the hand
b. pronation of the foot
*c. pronation of the forearm
d. pronation of the humerus
e. none of the above

34. Where is the origin of the flexor carpi radialis muscle?

*a. medial epicondyle of the humerus
b. medial epicondyle of the lateral humerus
c. medial epicondyle of the medial humerus
d. medial condyle oft the medial humerus
e. none of the above

35. What is the action of the palmaris longus muscle?

a. extension of the wrist
b. extension of the elbow
*c. flexion of the wrist
d. flexion of the elbow
e. none of the above

36. Where is the insertion of the flexor carpi ulnaris muscle?

a. base of the first metacarpal
b. base of the second metacarpal
c. base of the third metacarpal
d. base of the fourth metacarpal
*e. none of the above

37. Where is the insertion of the extensor carpi ulnaris muscle?

a. base of the first metacarpal
b. base of the second metacarpal
c. base of the third metacarpal
d. base of the fourth metacarpal
*e. none of the above

38. Where is the insertion of the extensor carpi radialis brevis muscle?

a. base of the first metacarpal
b. base of the second metacarpal
*c. base of the third metacarpal
d. base of the fourth metacarpal
e. none of the above

39. Where is the insertion of the extensor carpi radialis longus muscle?

a. base of the first metacarpal
*b. base of the second metacarpal
c. base of the third metacarpal
d. base of the fourth metacarpal
e. none of the above

40. Which muscle is responsible for the flexion of the thumb?

a. flexor digitorum superficialis
b. flexor digitorum profundus
*c. flexor pollicis longus
d. flexor digitorum
e. none of the above

41. Which muscle is responsible for the extension of the second metacarpal?

a. extensor digitorum
*b. extensor indicis
c. extensor carpi radialis longus
d. extensor carpi radialis brevis
e. none of the above

42. How many cervical vertebrae are there?

a. 5
*b. 7
c. 9
d. 11
e. none of the above

43. How many thoracic vertebrae are there?

a. 7
b. 9
c. 11
*d. 13
e. none of the above

44. Where is the origin of the rectus abdomonis muscle?

a. crest of the ilium
*b. crest of the pubis
c. linea alba
d. inguinal ligament
e. none of the above

45. What is the action of the external oblique abdominal muscle?

*a. lumbar extension
b. lumbar flexion
c. lateral rotation
d. lateral lumbar extension
e. none of the above

46. What is the action of the transverse abdominis muscle?

a. forced inspiration
*b. forced expiration
c. expiratory extension
d. expiratory depression
e. none of the above

47. When the pelvic girdle is anteriorly rotating the hip motion will be

a. extension
*b. flexion
c. abduction
d. adduction
e. none of the above

48. When the lumbar spine is in extension the hip motion will be

a. extension
*b. flexion
c. abduction
d. adduction
e. none of the above

49. What is the action of the iliopsoas muscle?

a. extension of the hip
b. flexion of the hip
c. internal rotation of the hip
d. external rotation of the hip
e. none of the above

50. Where is the insertion of the sartorius muscle?

*a. anterior medial condyle of the tibia
b. superior aspect of the patella and patellar tendon to the tibial tuberosity
c. iliotibial tract on the thigh one fourth of the way down
d. anterior iliac crest of the ilium just below the crest
e. none of the above

51. Where is the insertion of the rectus femoris muscle?

a. anterior medial condyle of the tibia
*b. superior aspect of the patella and patellar tendon to the tibial tuberosity
c. iliotibial tract on the thigh one fourth of the way down
d. anterior iliac crest of the ilium just below the crest
e. none of the above

52. Where is the origin of the tensor fasciae latae muscle?

a. anterior medial condyle of the tibia
b. superior aspect of the patella and patellar tendon to the tibial tuberosity
c. iliotibial tract on the thigh one fourth of the way down
*d. anterior iliac crest of the ilium just below the crest
e. none of the above

53. What is the best way to strengthen the gluteus medius muscle?

a. leg raises
b. hack squat
*c. hip abduction exercises
d. hip adduction exercises
e. none of the above

54. What is the best way to strengthen the gluteus minimus muscle?

a. swimming
*b. running
c. leg raises
d. hip extensions
e. none of the above

55. What is the best way to strengthen the biceps femoris?

a. arm curls
b. wrist curls
c. bench press
d. tricep extension
*e. none of the above

56. Where is the origin of the semitendinosus muscle?

a. head of the fibula
*b. ischial tuberosity
c. lateral condyle of the tibia
d. medial condyle of the tibia
e. none of the above

57. Where do you palpate the adductor brevis muscle?

a. middle third of the linea aspera
b. below the pubic bone on the medial side
c. medial side of the thigh below the pubic bone
*d. cannot be palpated
e. none of the above

58. Where do you palpate the gracilis muscle?

a. middle third of the linea aspera
b. below the pubic bone on the medial side
*c. medial side of the thigh below the pubic bone
d. cannot be palpated
e. none of the above

59. What muscle is responsible for keeping the knee straight?

a. rectus femoris
*b. vastus lateralis
c. vastus intermedius
d. vastus medialis
e. none of the above

60. Which is NOT a movement of the ankle and foot?

a. dorsi flexion
b. plantar flexion
c. inversion
*d. supination
e. none of the above

61. What is the best way to strengthen the flexor digitorum longus muscle?

a. calf raises
b. heel raises
c. jump rope
*d. towel grabs
e. none of the above

62. What is the action of the peroneus longus muscle?

a. inversion of the ankle
b. eversion of the ankle
c. dorsi flexion of the ankle
d. plantar flexion of the ankle
*e. none of the above

63. What is the action of the tibialis posterior muscle

a. inversion of the ankle
b. eversion of the ankle
c. dorsi flexion of the ankle
*d. plantar flexion of the ankle
e. none of the above

64. Which of the following is NOT a bone of the hand?

a. lunate
b. pisiform
c. trapezium
*d. calcaneus
e. none of the above

65. If an athlete broke a bone in the second phalange, the proximal phalanx, which joints may have been affected?

a. distal and proximal interphalangeal
b. distal and proximal metacarpophalangeal
*c. metacarpophalangeal and proximal interphalangeal
d. interphalangeal and distal interphalangeal
e. none of the above

66. If an athlete shatter their heal bone what bone would be affected?

a. talus
b. navicular
*c. calcaneus
d. sesamoid
e. none of the above

67. If an athlete took a blow to the back of the head they are in danger of fracturing what bone?

a. parietal
b. sphenoid
c. frontal
*d. occipital
e. none of the above

68. Where is the coracoid process located?

a. knee
b. elbow
c. wrist
*d. shoulder
e. none of the above

69. Where is the supraspinous fossa located?

a. knee
b. elbow
c. wrist
*d. shoulder
e. none of the above

70. If an object travels a distance of 12m in a straight line in 3 sec. its average speed is:

a. 2 m/s
b. 3 m/s
*c. 4 m/s
d. 36 m/s
e. none of the above

71. If an object travels a distance of 12m in a straight line in 3 sec. its average velocity is:

a. 2 m/s
b. 3 m/s
*c. 4 m/s
d. 36 m/s
e. none of the above

72. If an object travels a distance of 12m in a straight line in 3 sec. its average acceleration is:

a. 2 m/s
b. 3 m/s
c. 4 m/s
d. 36 m/s
*e. none of the above

73. Scalars deal with:

a. directions
b. displacement
*c. magnitude
d. acceleration
e. all of the above

74. If an object is traveling in a straight line (north) at 10 m/s and there is an easterly wind pushing the object at 20 m/s what is the resultant velocity?

a. 500 m/s
*b. 22.36 m/s
c. 5.47 m/s
d. 3.26 m/s
e. none of the above

75. What direction is the object traveling?

a. 90 degrees
b. 78 degrees
c. 63 degrees
*d. 27 degrees
e. none of the above

76. If an object is traveling in a northwesterly direction at 10 m/s and there is an easterly wind pushing the object at 20 m/s what is the resultant velocity?

a. 500 m/s
*b. 22.36 m/s
c. 5.47 m/s
d. 3.26 m/s
e. none of the above

77. What direction is the object traveling?

a. 90 degrees
b. 78 degrees
c. 63 degrees
d. 27 degrees
*e. none of the above

78. If a Pluto disk is thrown due north at 13 m/s and the wind is blowing due east at 5 m/s what is the resultant velocity?

a. 194 m/s
b. 16.37 m/s
*c. 13.93 m/s
d. 6.57 m/s
e. none of the above

79. If a Pluto disk is thrown due north at 13 m/s and the wind is blowing due east at 5 m/s what direction is it traveling?

a. 90 degrees
*b. 69 degrees
c. 59 degrees
d. 21 degrees
e. none of the above

80. If a Pluto disk is thrown northwest at 17 m/s and the wind is blowing due east at 7 m/s what is the resultant velocity?

a. 194 m/s
b. 16.37 m/s
c. 13.93 m/s
d. 6.57 m/s
*e. none of the above

81. If a Pluto disk is thrown northwest at 17 m/s and the wind is blowing due east at 7 m/s what direction is it traveling?

a. 90 degrees
b. 69 degrees
c. 59 degrees
d. 21 degrees
*e. none of the above

82. If an individual is lying on his/her stomach trying to lift a weight of 200 lbs. with the hamstrings and the angle of the legs is 70 degrees how much force is being generated from the rotary component?

a. 200 lbs
b. 192 lbs
*c. 188 lbs
d. 100 lbs
e. none of the above

83. If an individual is lying on his/her stomach trying to lift a weight of 200 lbs. with the hamstrings and the angle of the legs is 70 degrees how much force is being generated from the stabilizing component?

a. 200 lbs
b. 192 lbs
c. 188 lbs
*d. 100 lbs
e. none of the above

84. How long would it take an object to fall from 200m?

a. 40.77s
b. 35.45s
*c. 6.39s
d. 4.90s
e. none of the above

85. If an individual is curling a weight of 200 lbs. with his/her arm and the arm is at a 5 degree angle what is the force of the rotary component?

a. 199.2 lbs
b. 76.2 lbs
c. 64.3 lbs
*d. 17.4 lbs
e. none of the above

86. If an individual is curling a weight of 100 lbs. with his/her arm and the arm is at a 50 degree angle what is the force of the stabilizing component?

a. 199.2 lbs
b. 76.2 lbs
*c. 64.3 lbs
d. 17.4 lbs
e. none of the above

87. If it takes me .1 secs. to fall from a box what is my displacement and distance?

a. 9.81 m
b. .981 m
c. .069 m
*d. .049 m
e. none of the above

88. If it takes me 6 secs. to jump 50 m what is my acceleration?

a. 50 m/(s)2
b. 27 m/(s)2
c. 4.5 m/(s)2
*d. 2.8 m/(s)2
e. none of the above

89. If it takes me 6 secs. to jump 50 m what is my final velocity?

*a. 16.7 m/s
b. 14.5 m/s
c. 13.2 m/s
d. 5 m/s
e. none of the above

90. If an object travels 40 degrees in 3 secs. what is its angular speed?

a. 15 degrees/sec
*b. 13 degrees/sec
c. 10 degrees/sec
d. 7 degrees/sec
e. none of the above

A right handed bowler takes up his stance with his right (upper) arm 10 degrees forward of a downward vertical through his right shoulder. He then swings his arm clockwise (as viewed from his right-hand side) until it reaches a position 20 degrees above a horizontal line through his shoulder. From his backward limit of his backswing, he then swings his are counterclockwise and releases the ball. If his are is 15 degrees forward of a downward vertical line through the shoulder at release:

91. What is the angular distance?

a. 255 degrees
*b. 245 degrees
c. 45 degrees
d. 35 degrees
e. none of the above

92. What is the angular displacement (if counterclockwise is the positive direction)?

a. 20 degrees
b. 15 degrees
c. 10 degrees
*d. 5 degrees
e. none of the above

93. If the backswing delivery took a total of 2.2 secs. what was the average angular speed of his arm?

a. 113 degrees/s
*b. 111 degrees/s
c. 109 degrees/s
d. 107 degrees/s
e. none of the above

94. If the backswing and delivery took a total of 2.2 secs. what was the average angular velocity of the arm?

a. 3.45 degrees/s
b. 3.11 degrees/s
*c. 2.27 degrees/s
d. 1.34 degrees/s
e. none of the above

95. If the mass of object one is 10 and the mass of object two is 15 and the distance between them is 5 m what is the force?

a. 150
b. 75
c. 65
d. 30
*e. none of the above

96. If an object weighs 402 N what is its mass?

a. 67.95 kg
*b. 40.97 kg
c. 32.87 kg
d. 12.45 kg
e. none of the above

97. If a force of 1400 N is being generated to move an object and the normal reaction of the object is 2000 N the coefficient of limiting friction is?

a. .8 N
*b. .7 N
c. .6 N
d. .5 N
e. none of the above

98. What is the oblique impact of an object with a fixed surface if the horizontal velocity is 45 and the vertical velocity is 5?

a. 9
b. 6
c. .23
*d. .11
e. none of the above

99. If an object weighs 600 N and is resting on an area of .02 (m)2 what is the pressure equal?

*a. 30,000 Pa
b. 13,000 Pa
c. 12 Pa
d. 9 Pa
e. none of the above

100. If the magnitude of force is equal to 1800 N and the distance of this force is .5 m what is the work equal?

*a. 900 J
b. 600 J
c. 300 J
d. 150 J
e. none of the above

101. What do the horizontal adductors to the arm during a baseball pitching motion?

a. pull the arm away from the side and externally rotate it
b. pull the arm to the side and internally rotate it
*c. pull the arm forward and externally rotate it
d. none of the above

102. What causes the vertical deviations of a pitched baseball?

a. height of release
b. coefficient of restitution
*c. gravity and air resistance
d. speed and velocity of the ball
e. none of the above

103. The angle of a pitched baseball is governed by:

*a. height of release
b. coefficient of restitution
c. gravity and air resistance
d. speed and velocity of the ball
e. none of the above

104. What type of baseball pitch will have the greatest degree of rotation?

a. slider
b. fast ball
c. curve ball
*d. sidearm curve ball
e. a and c

105. What type of baseball pitch will have the greatest amount of rotation (i.e., revolutions per second)?

a. slider
b. fast ball
c. curve ball
*d. sidearm curve ball
e. c and d

106. Which of the following is NOT part of a batting analysis?

a. stance
b. stride
c. swing
d. follow-though
*e. none of the above

107. What effects the accuracy of a basketball shoot the most?

a. angle of entry
b. height of release
*c. distance of the shot
d. speed and angle of release
e. none of the above

108. What angle of entry of a basketball into the basket has the least margin for error?

*a. 90 degree
b. 80 degree
c. 70 degree
d. 60 degree
e. none of the above

109. What is the most frequently used and most reliable pass in basketball?

*a. chest
b. bounce
c. overhead
d. baseball
e. none of the above

110. What is the optimal angle at contact with the foot to kick a football to maximize distance?

a. 45 degree
b. 30 degree
c. 25 degree
*d. 15 degree
e. none of the above

111. What of the following is NOT a factor that effects the distance a punt will travel?

a. angle of release
b. distance ball dropped
c. velocity of ball at release
*d. none of the above

112. Which of the following is NOT a factor in the length of carry of a golf ball?

a. speed
*b. gravity
c. air resistance
d. height of the ball when contacted by the face of the club
e. none of the above

113. Speed of release of a golf ball can be calculated by:

a. angular acceleration
b. Newton's law of impact
*c. coefficient of restitution
d. impact principle of cosine
e. none of the above

114. What is the best grip in golf?

a. Vardon
b. baseball grip
c. interlocking grip
*d. none of the above

115. What movement initiates the downswing in a golf?

a. backward movement of the hands
b. forward movement of the hands
*c. forward movement of the hips
d. rotation of the trunk
e. none of the above

116. Which of the following is NOT a phase of movement in the long horse vault?

a. run-up
b. takeoff
c. preflight
d. hurdle step
*e. none of the above

117. Which of the following is NOT a vaulty technique?

a. squat
b. hecht
*c. Arabesque
d. Tsukahara
e. none of the above

118. Frictional forces tend to weaken a gymnast's grip when the gymnast:

a. swings forward
*b. swings backward
c. dismounts
d. vaults
e. none of the above

119. What helps a gymnast angularly accelerate the body on the uneven bars the most?

a. mass
b. gravity
c. centripetal component
*d. tangential component
e. none of the above

120. The point of release of the softball when being pitch has what type of force acting upon it?

a. centrifugal
*b. centripetal
c. concentric
d. eccentric
e. none of the above

121. What are the components of stroking time for a swimmer?

a. distance and average acceleration
*b. distance and average speed
c. displacement and friction
d. displacement and drag
e. none of the above

122. Which of the following is NOT a resistive force?

*a. surface drag
b. stroke drag
c. form drag
d. wave drag
e. none of the above

123. Which of the following is NOT a part of the pull phase?

a. initial press
*b. final press
c. inward scull
d. outward scull
e. none of the above

124. When does a swimmer encounter the greatest amount of resistance during the breaststroke?

a. glide
*b. recovery
c. pre-thrust
d. post-thrust
e. none of the above

125. Which start is the fastest in terms of start and time to entry?

*a. flat
b. pike
c. track
d. scoop
e. none of the above

126. Which start has the smallest angle of entry?

*a. flat
b. pike
c. track
d. scoop
e. none of the above

127. Which of the following is NOT considered when calculating stride length?

a. flight distance
*b. stride distance
c. takeoff distance
d. landing distance
e. none of the above

128. The optimum inclination of the trunk while running is determined by:

a. center of gravity
b. law of momentum
c. coefficient of restitution
*d. moments of the eccentric forces
e. none of the above

129. What determines and athletes angle of takeoff when performing the long jump?

a. vertical velocity and acceleration
*b. horizontal speed and vertical speed
c. horizontal lift and vertical velocity
d. average speed and final velocity
e. none of the above

130. Which of the following is NOT a consideration in the high jump?

a. clearance height
b. takeoff height
c. flight height
*d. cross height
e. none of the above

131. Which of the following is NOT a high jump technique?

a. scissors
b. straddle
c. Eastern cutoff
d. Western roll
*e. none of the above

132. The amount of energy "stored" in the pole at the instant of takeoff in the pole vault is known as:

*a. strain energy
b. kinetic energy
c. elastic energy
d. inelastic energy
e. none of the above

133. The following is NOT a phase in the shot put.

a. initial stance
b. delivery
*c. release
d. glide
e. none of the above

134. The following is NOT a phase in the discus.

a. transition
b. delivery
c. reverse
d. turn
*e. none of the above

135. The moment of inertia of a gymnast is smallest about:

a. an axis through the hands during a giant swing
b. an axis through the center of gravity during a tuck
*c. a longitudinal axis at the intersection of the frontal and median sagittal planes during a twist
d. an axis through the shoulders during an arm supported swing on the parallel bars

136. All of the following stunts or dives, while airborne, are about a transverse axis EXCEPT:

a. pike forward dive
b. 1½ somersault pike
c. layout forward dive
d. tuck somersault
*e. full twist

137. Which of the following dives has the largest moment of inertia?

a. pike forward dive
b. full twisting forward dive
*c. layout forward dive
d. tuck somersault

138. A rotating body will continue to turn about its axis of rotation with constant angular momentum unless acted upon by:
a. a force
b. a couple
c. a moment
d. a torque
*e. b, c and d

139. In which of the following is air resistance so small, less than 1%, that it can essentially be neglected?

a. badminton clear
b. baseball pitch
c. discus throw
*d. shot put

140. A person can float in water if all of the following conditions are true except:

a. the weight of the water displaced by the body equals body weight
*b. the specific gravity of the body is greater than 1
c. there is a large percentage of body fat present
d. the person's lungs are full of air

141. When a person lies horizontally face down in the water with no forward motion, the legs drop for all of the following reasons except:

*a. the center of buoyancy of the body is in-line with the center of gravity of the swimmer
b. the specific gravity of the legs is greater than that of water.
c. there is no forward movement of the body through the water to lift the legs
d. there is not as much fat or air in the legs as the torso

142. With regard to fluid resistance, lift is:

*a. a force perpendicular to the drag force
b. is the drag force
c. dependent upon the type of surface that is going through the fluid
d. a and c

143. In an attempt to reduce surface drag in rowing, all of the following will lower this force except:

a. making the surface smoother
b. making the total surface smaller
*c. decreasing the total weight in the shell
d. all of the above will reduce the surface drag

144. The layer of air in close contact with the surface of the object that is compressed when the object moves through the air is called:

a. lamina
b. eddy
*c. boundary
d. turbulence

145. The drag force generated by an object that goes through the air based upon its cross-sectional area perpendicular to the direction of air flow is called:

a. surface
*b. form
c. eddy
d. wave

146. The optimum angle of attack of the discus is:

a. 27°
b. 28°
*c. 10°
d. 0°
e. a and b

147. The Magnus effect is used in sport. In which one of the following examples is the Magnus effect NOT used in a strategic way?

a. slice in golf
b. curve in pitching
c. corner kick in soccer
*d. free throw in basketball

148. Fielding a ball and getting it to the proper base is a race against time. What factor is NOT relevant to the total time from the bat hitting the ball until the ball reaches the appropriate base?

a. the fielder runs toward the hit ball
b. angle of release of ball during throw
c. velocity of ball at release
d. direction of the wind
*e. all of these factors are relevant

149. Which one of the following statements is incorrect?

a. the length of the stride has an effect on how fast a ball can be pitched
b. the back foot is not in contact with the rubber at release
*c. a pitcher must release all of his pitches at an angle above horizontal
d. sliders drop farther than curve balls from release to the strike zone.

150. Which of the following purposes for the follow-through in the pitch is incorrect?

a. to prevent high internal forces in muscles and joints from injuring the pitcher
b. to produce the correct force application to the ball at release which would be prevented by stopping prior to release
c. increases the time of slowing down all high speed moving segments of the body
d. helps to control the direction of the pitch
e. all are correct

151. Which of the following statements with regard to batting is incorrect? (right handed batter)

a. a line connecting the toes of the batter's feet is directed to right field and is called a closed stance
b. a line connecting the toes of the batter's feet is directed to second base and is called a square stance
c. the farther back in the box a batter stands the longer the time it takes to "read" the pitch
*d. the closer the batter stands to the plate the more affected the batter is with an "outside" pitch

152. Which of the following statements is incorrect about a batter with a closed stance?

*a. does not get as much distance to exert the muscular forces responsible for rotating the hips, shoulders and arms to the front
b. a right-handed batter will tend to hit into right field with a closed stance
c. is used by batters who can get their bat around quickly
d. is used by batters whose dominant eye is not on the same side as their dominant arm

153. Which of the following is NOT true concerning correct form in batting?

a. having the weight on the back foot before the swing is necessary to get the most force into the ball during the swing
*b. a short step toward the field that the batter wants to hit the ball
c. a low step into the pitch, just high enough to clear the spikes
d. faster swing times give more decision time

154. In batting which of the following is true?

a. It takes longer for a left handed batter to get to the base than a right-handed batter
b. A left handed batter on the average does not reach as high a running speed as the right-handed batter
c. A batter will get a little more force into the ball by rolling the wrists into the impact
d. A batter should extend his front arm (arm nearest the pitcher) as ball is contacted
*e. b and d

155. The trajectory that a basketball follows on its way to the basket is influenced by all the following except:

a. air resistance
b. height of release
c. velocity of release
d. angle of release
*e. all of the above influence the trajectory

156. The most frequently used pass in a basketball game is the:

a. one-hand baseball pass
b. one-hand bounce pass
*c. two-hand chest pass
d. two-hand bounce pass

157. The angle of entry of a basketball with the basket rim which will give the ball the maximum chance of going in is:

a. 60°
b. 33°
c. 90°*
d. 45°

158. A player shoots the basketball toward the basket in an attempt to make a shot. He releases it at a height of 2.3 m to CG of ball, at a horizontal distance of 5m to the center of the basket. The basket is 3.05 m high, the ball is 24.7 cm in diameter and the basket is 45.7 cm in diameter. If the angle of release is 60° and the velocity of release is 7 m/sec, how close to the center of the basket does the center of the ball get? (Hint: compute time-up, distance up, and time down. Horizontal distance is total time X horizontal velocity).

a. 1.50 m
*b. 0.56 m
c. 0 m
d. 2.23 m

159. The most successful type of basketball pass as measured by the percentage of passes completed was the:

a. one-hand baseball pass
*b. two-hand chest pass
c. one-hand bounce pass
d. two-hand bounce pass

160. In a study of the jump shot in basketball, top-level vs average players were compared. The better ball players did all of the following except:

a. traveled less distance horizontally during jump
*b. elbow of shooting arm was further from the ball-basket line
c. at take-off into the jump the ball had greater vertical velocity
d. shot was released later in the jump
e. non-shooting hand was removed from the ball later

161. A pass in football includes all of the following except:

a. hand-off from one player to another
b. center snap in a punt
c. lateral pass between players
d. a quarterback throwing the ball down field to a receiver
*e. all of the above are passes

162. Increasing the velocity of a blocker at impact does all of the following except:

a. increase momentum of blocker
b. increase the force the opponent needs to resist the blocker
*c. blocker decreases the impulse of the blocker
d. makes it easier to move the opponent

163. The least important factor in the kicking of a ball is:

a. the velocity of the foot at impact
*b. the velocity of the ball at impact
c. the mass of the foot
d. the angle of release at impact

164. Which statement is incorrect?

a. air resistance causes lift to the punted football and causes it to go further than it would travel in a vacuum*
b. the optimum angle of projection for a place kick to obtain distance is 30°
c. the speed of release of the football is greater in the the place kick than the punt
d. all of the above are correct

165. For running as fast as possible from 2, 3 or 4 point stance which of the following statements is incorrect?

a. two-point stance was fastest for running diagonally to the right and left
b. the three-point stance was fastest running straight ahead
c. the two-point stance is the fastest for running 90° to the side
*d. It depends on the distance for which the times were recorded

166. The spin imparted to the golf ball is dependent upon all except:

a. direction of normal force
b. frictional force perpendicular to normal force vector
c. angle of loft
d. direction of angle of release
*e. all of the above

167. The distance a golf ball is hit depends upon all of the following except:

*a. club head mass (according to Daish)
b. club head velocity
c. air resistance
d. velocity of ball release
e. all of the above

168. In golf when a club face strikes the ball the angle of projection of the ball is dependent upon all of the following except:

a. direction club is moving
b. angle of inclination of club face
c. normal force at impact
*d. club head-body-ground force chain
e. all of the above

169. Concerning the soccer-style place kick in football, which of the following statements is incorrect?

a. Manzi found that for a two step approach the soccer style was not superior than the straight approach
*b. according to Plagenhoef the foot velocity in the soccer style kick was greater
c. it generated higher release velocities than conventional style
d. according to Bona the soccer style kick has greater accuracy

170. Which of the following statements about the downswing is incorrect for a right-handed golfer?

a. The left wrist acts as a free hinge at ball contact (Milburn)
b. The right hand pushes the club at hitting area (Cochran and Stobbs)
*c. The force couple produced at the grip adds considerable acceleration to the clubhead during ball contact area (according to Williams)
d. all are correct

171. Which of the following statements is incorrect regarding putting?

*a. moving the mass of the club head to the heel and toe of the club reduces its moment of inertia
b. ball must be hit on the CG of the club head for best results
c. it is not practical to put any spin on the ball
d. moving some of the mass of the putter to the heel and toes of the club helps reduce the effect of hitting the clubhead off center

172. Which putter design is superior to the others?

a. blade-style
b. mallet
c. center shaft
*d. none of the above

173. The angular momentum of a gymnast doing stunts that require rotation in the air is determined by:

a. moment of inertia of body in air
b. reaction force on the ground at take-off
c. height of the gymnast in the air during stunt
*d. all of the above

174. The rapid and forceful hip extension in the kip off of the floor does all of the following except:

a. raise the CG higher
*b. increase angular momentum
c. increase ground reaction force (GRF)
d. all of the above

175. In order to do the forward somersault all of the following are correct except:

*a. the line of force from the ground is directed through the CG at take-off
b. is a tightly tucked forward roll in the air
c. takes off of both feet
d. horizontal braking component of the GRF is responsible for the majority of the angular impulse

176. A round-off is used for all of the following in floor exercise except:

a. changing from forward to backward exercises
b. adding more horizontal velocity
*c. adding greater angular momentum around the longitudinal axis
d. getting greater GRF

177. Which of the following long horse vaults does not have a backward angular momentum phase after take-off from the board?

a. squat
b. hecht
c. straddle
*d. handspring

178. As a gymnast swings on the high bar, energy is lost in the downswing. The gymnast can control this by doing all of the following except:

a. piking or arching just after the body CG passes vertically below the bar.
b. starting the downswing from a higher height of the CG
c. increasing the distance of the CG to bar on the downswing
*d. all of the above are correct

179. The single most important factor that will allow a gymnast to return to a handstand position after a forward giant swing is:

a. starting from a handstand position
b. stretching out during the downswing
c. applying increased muscular force during upswing
*d. shortening distance from high bar to CG during upswing

180. The starting time for a swimmer consists of all of the following components of time except the time from:

*a. the "get set" to the start signal
b. first movement to leaving the blocks
c. leaving blocks to touching the water
d. touching the water until start of kick or stroke
e. all of the above are correct

181. The propulsive force from the legs is greatest in which swimming stroke?

a. back
b. butterfly
*c. breast
d. crawl

182. Which of the following statements is incorrect with regard to the arm propulsion?

a. lift forces contribute more to forward motion than drag forces
b. lift forces occur perpendicular to the drag forces
*c. the hands of the breaststroker move backwards slightly in the water during the push
d. the human hand develops more propulsion with the fingers together than slightly apart

183. Stroke length is decreased by all of the following except:

a. wave drag
b. form drag
c. surface drag
*d. lift

184. The least drag while kicking with a flutter kick is using:

a. a 30 cm kick
b. a 15 cm kick
c. no kick
d. a normal kick
*e. a and d

185. Faster swimmers in the free style events in the 1976 Olympic trials showed that:

a. the stroke length increased and stroke frequency decreased
b. both stroke length and frequency were greater
*c. stroke length was smaller and stroke frequency was greater
d. stroke length increased while stroke frequency stayed the same

186. For a fly turn in swimming the most significant aspect to the success of the turn is:

*a. impulse generated during foot contact
b. time for turn
c. hand contact time
d. time out

187. As a crawl swimmer's speed increases, all of the following are true except:

*a. swimmer rides lower in the water
b. the greater the form drag
c. an increase in wave drag
d. all of the following are true

188. The greatest amount of propulsion in the flutter kick comes from:

a. the knee extension phase
b. squeezing of the water between the legs
c. the up-kick phase generated from the plantar surface of the foot and lower leg
*d. hip torques

189. The method of crawl stroke arm path in which the sculling action is de-emphasized and shoulder extension is emphasized is called:

*a. Schwanhauser technique
b. Montgomery technique
c. Spitz technique
d. Hall technique

190. Drag forces on the body as it goes through the water:

a. can be eliminated by shaving the body
b. are decreased by using the sculling motion
c. are equal to the lift forces
*d. are proportional to the square of the velocity

191. During the breast stroke all the following are true except:

a. the inward sculling motion generates the most propulsion in the arm stroke
*b. the most effective leg kick currently used is the frog kick
c. the knees should not separate wider than a line connecting hips and heels
d. during the recovery phase of the leg kick is where the greatest drag forces exist in the stroke

192. The swim starts of the following strokes are the same except for:

*a. back stroke
b. breast stroke
c. crawl stroke
d. butterfly

193. Guimaraes investigated start time and found that:

a. the glide distance varied considerably among swimmers
b. the horizontal velocity of the swimmers varied considerably among swimmers
*c. drag forces exerted during the glide were the most important factor in determining start time
d. the starting position on the block with arms at side and hands higher than the shoulders was superior

194. A running stride is made up of all of the following components except:

a. landing distance
b. flight distance
*c. take-off distance
d. all of the above are correct

195. As the athlete tries to run faster, all of the following occur except:

a. product of stride length and stride rate increase
b. take-off distance increases with acceleration
c. ground contact time increases proportionately
d. flight time increases proportionately

196. The average stride length of a sprinter is computed by:

a. taking the first stride and the last stride and averaging them
b. taking the number of strides and dividing into the distance from the start line to the finish line
c. taking the distance from the starting blocks of the rear leg to the end of the last stride immediately before the finish line and dividing by the number of strides
*d. taking the distance from the start line to the end of last stride immediately before finish line and dividing by the number of strides

197. In comparing male and female sprinters, a female sprinter:

a. has proportionately much shorter average stride lengths
*b. has much lower stride frequencies
c. has higher ratios of stride length/height
d. has higher ratios of stride length/leg length

198. With regard to sprint velocity during a 100m race, which statement is incorrect?

a. an athlete reaches top speed between 30 to 50 m (Gundlach)
b. 90% of maximum velocity is reached by 15-20 yds
*c. 91% of maximum velocity is reached in 2 seconds
d. maximum speed is reached between 50-70 m (Mehrikadze)

199. Concerning the sprint start studied by Henry, which of the following is true:

a. the bunch start results in quicker times leaving the blocks and faster 10 and 50 yard times
b. the best runs came from foot spacings of 55 cm
c. the 66 cm foot spacing resulted in a greater velocity leaving the blocks and at 10 and 50 yards
*d. the medium start was superior to the bunch and elongated

200. A running cycle is composed of all of the following phases except:

*a. swing phase
b. recovery phase
c. support phase
d. driving phase